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Analysis of Mathematical Critical Thinking Skills Based on Students' Learning Styles in Junior High School

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Abstract

Critical thinking is vital for learning statistics in mathematics. This study aims to evaluate the critical thinking abilities of eighth-grade students at Muhammadiyah Pakem Junior High School by considering their learning styles in the context of statistics. This qualitative research involved two students selected through purposive sampling as research subjects from each learning style: visual, auditory, and kinesthetic. Data were collected via questionnaires, tests, and interviews. The data processing techniques applied included data presentation, data reduction, and conclusion drawing. The research findings indicate that: (i) students with a visual learning style demonstrated exceptional critical thinking skills, aligning with the indicators of interpretation, analysis, evaluation, and inference; (ii) students with an auditory learning style exhibited strong abilities in evaluation, analysis, and inference, although their interpretation skills were not fully developed; and (iii) students with a kinesthetic learning style possessed good skills but had not yet fully met the indicators of analysis and evaluation. Furthermore, students with a visual learning style were considered more proficient in critical thinking, as they were able to explain visual representations of mathematical concepts before solving problems. On the other hand, auditory and kinesthetic learners still have the potential to further develop their critical thinking skills.

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INTRODUCTION

Critical thinking skills are essential competencies that students must possess to face the dynamic challenges of the 21st century (Szabo et al., 2020). In the educational context, this ability aids students in deeply analyzing information, making rational decisions, and effectively solving problems by considering various perspectives (Dolapcioglu & Doğanay, 2022). This competency serves as one of the main foundations in building character and skills, enabling students to adapt to the ever-changing developments in technology and globalization. This aligns with the demands of the Merdeka Curriculum, which emphasizes the development of higher-

order thinking skills to equip students to become adaptive, innovative, collaborative individuals with good communication abilities (Tarso et al., 2025).

Despite various advancements in Indonesia's education system, students' critical thinking skills across different educational levels still face significant challenges (Budiyanto et al., 2024). Many students tend to rely on rote memorization without a deep understanding of the concepts being studied (Aristin & Purnomo, 2022). As a result, they often struggle to analyze problems, evaluate information, or develop logical arguments. This indicates that critical thinking skills have not developed optimally in the learning process, particularly in statistics education.

Statistics education plays a crucial role in Indonesia's educational curriculum (Fauziyyah & Nurjanah, 2024). Statistics not only functions as a branch of mathematics but also serves as an essential tool in various disciplines and everyday life (Musyafak & Agoestanto, 2022). Through statistics education, students are taught how to systematically collect, process, analyze, and present data. This ability is vital in today's information era, where data forms the basis for accurate decision-making, understanding trends, and predicting various possibilities in the future. However, the challenges in learning statistics in Indonesia are still quite significant (Casinillo, 2023). For example, research conducted by Suryani and Haryadi (2022) shows that students' critical thinking abilities in solving statistical problems are in the low category, with an average score of only 46.87. This shows that many students have difficulty interpreting data, choosing appropriate analysis methods, and drawing valid conclusions from the data presented.

One factor that can influence the effectiveness of statistics education is students' learning styles. Each student has different learning preferences, such as visual, auditory, or kinesthetic, which affect how they understand and process information (Ying, 2024). Understanding these learning styles is important so that educators can design appropriate learning strategies, allowing statistical material to be absorbed more effectively by all students. Research has shown that the alignment between teaching styles and students' learning styles can improve the quality of learning (Dominguez et al., 2025). By adjusting teaching methods to students' learning styles, educators can help students achieve deeper understanding and better learning outcomes.

Learning styles essentially represent approaches that make individuals feel more comfortable and capable during the learning process. The most popular learning style model is VAK, which includes visual, auditory, and kinesthetic (Atieku et al., 2023). Visual learners quickly understand material through sight, such as reading books, watching demonstrations, or learning from media like videos and TV. Meanwhile, auditory learners tend to learn better by listening, so methods like lectures, Q&A, or discussions are more effective for them. Kinesthetic learners take a different approach, as they learn best through physical activities, using hand, foot, or even whole-body movements to help understand the material. Given these varied learning styles, it is crucial for educators to recognize and understand students' learning characteristics to optimize the learning process.

Muhammadiyah Pakem Junior High School is one educational institution committed to improving student quality, particularly in developing critical thinking skills. As a school based on Islamic and academic values, Muhammadiyah Pakem Junior High School faces challenges in identifying student characteristics, including variations in learning styles, to ensure optimal learning outcomes. However,

research specifically examining the relationship between learning styles and critical thinking skills in this school is still limited. A deeper understanding of how learning styles affect students' critical thinking is needed to design more targeted learning interventions (Guo et al., 2024).

Based on preliminary tests at Muhammadiyah Pakem Junior High School, data shows that the average mathematics scores of students are still below the minimum mastery standard, indicating difficulties in students' critical thinking skills. Research by Purwanto et al. (2020) also shows low critical thinking abilities in mathematics. Facione (2011) identifies four indicators of critical thinking: (1)Interpretation, the ability to understand and express the meaning of experiences; (2) Analysis, the ability to identify inferential relationships between statements or representations; (3) Evaluation, the ability to assess the credibility of statements and the logical strength of inferential relationships; (4) Inference: The ability to make logical conclusions and consider relevant information.

Bahri et al. (2024) conducted research on critical thinking abilities related to students' cognitive styles, finding differences in critical thinking abilities between field-dependent and field-independent cognitive styles. On the other hand, Arafah et al. (2025) concluded that learning style does not affect critical thinking abilities, although differences exist among visual, auditory, and kinesthetic learning styles. However, Behzadi and Momennasab (2023) found no significant differences in critical thinking abilities based on these learning style categories. This motivates the author to further investigate the critical thinking abilities of Muhammadiyah Pakem Junior High School students based on their learning styles. Critical thinking allows students to process the knowledge or information they receive logically, encouraging independent learning (Irwan et al., 2024).

This research has several main differences compared to previous studies. First, the focus of this research is on statistical material in mathematics learning, which has not been widely explored in the context of the relationship between learning styles and critical thinking skills. Second, the research location at Muhammadiyah Pakem Junior High School provides a unique context different from other studies, allowing for more specific analysis of the characteristics of students at the school. Third, this research considers the implementation of the Merdeka Curriculum, which emphasizes the development of higher-order thinking skills, making the results relevant to current educational policies. Thus, this study is expected to provide significant contributions in understanding how learning styles affect students' critical thinking skills, especially in statistics learning in a dynamic educational environment.

RESEARCH METHODS

Data collection was conducted using a learning style questionnaire, a critical thinking skills test consisting of five questions, and interviews. The learning style questionnaire comprised 25 items using a four-point Likert scale, including 10 questions for the visual learning style, 9 for auditory, and 6 for kinesthetic, which were administered before the learning process. Based on the questionnaire results, students were grouped according to the highest scores in one of the learning style categories, resulting in a final distribution of 5 visual learners, 8 auditory learners, and 9 kinesthetic learners. Subsequently, each learning style visual, auditory, and

kinesthetic was represented by two students selected through purposive sampling as research subjects.

Interviews were conducted with the selected students to obtain additional information regarding their critical thinking skills in the statistics material they had studied, supported by audio recordings and documentation of students' work. In this study, critical thinking skills refer to the aspects outlined by Facione (2011), which were used as the basis for the test. Data analysis was carried out using the Miles and Huberman model, which includes data reduction, data presentation, and conclusion drawing or verification (Sugiyono, 2019). Additionally, time triangulation was employed to enhance the validity of the data. Through this approach, this study aims to identify and describe students' critical thinking skills based on their learning styles whether visual, auditory, or kinesthetic to provide a more comprehensive understanding of the relationship between learning styles and students' critical thinking abilities.

RESEARCH RESULTS

The learning style questionnaire was tested on 22 students and categorized the students based on their learning styles. The results of the analysis of the students' learning style questionnaire can be seen in Table 1.

Table 1. Learning style category data

Learning Style	Total Students	Research Subjects	Students' Code Name
Visual	5	V1	MA
		V2	AAP
Auditorial	8	A1	AGA
		A2	HER
Kinesthetic	9	K1	ALA
		K2	AT

Based on Table 1, the analysis of the student learning style questionnaire shows that each learning style category was selected by two students. After filling out the questionnaire, this study obtained the results of the written critical thinking ability test and interview transcripts. The interview results for each subject are explained and described in order to assess students' critical thinking abilities. The following are the results of the written test and interview transcripts for subjects with visual, auditory, and kinesthetic learning styles.

Subject 1: MA

Question number 1 "Based on the diagram below, it is known that classes VIII-A, VIII-B, and VIII-F have an average of 80, determine the average value of the other classes".

The subject V1, with the initials MA, answered question number 1 carefully and presented the solution completely. Subject V1 wrote the information from question number 1 in full. In the analysis stage, subject V1 correctly stated the formula for the average. In the evaluation stage, subject V1 was able to perform the calculation using the formula provided and arrived at the correct solution. In the inference stage, subject V1 was able to draw a conclusion accurately.

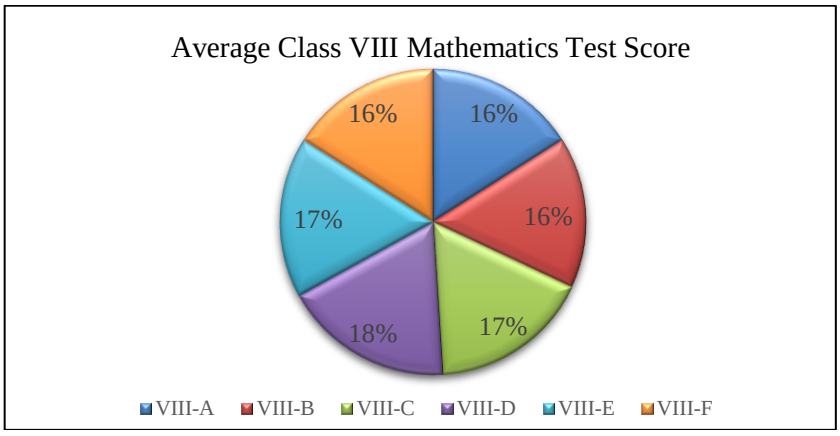
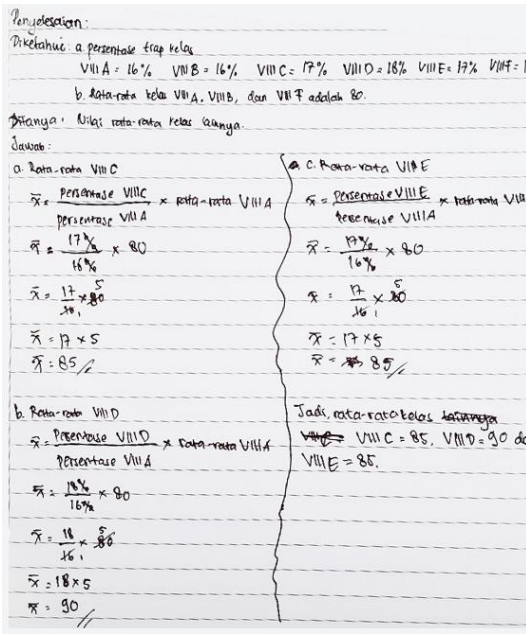


Figure 1. Diagram of question number 1

Subject V1 has fulfilled the steps of solving question number 1 and demonstrated critical thinking skills. However, during the process, subject V1 was slightly less careful, as there was an error in writing the final result. On the other hand, subject V2 also successfully completed the steps of solving the problem, in accordance with the indicators of critical thinking skills. The solution results of V1 are in Figure 1.



Completion

Given: a) The persentage each class
VIIIA=16%, VIIIB=16%, VIIIC=17%, VIIID=18%, VIIIE=17%, VIIIF=16%
b) The average of class VIIIA, VIIIB, and VIIIF were 80

Find: the average of other class

Answer

a. Average of VIIIC

$$\bar{x} = \frac{\%\,\text{VIIIC}}{\%\,\text{VIIIA}} \times \text{average VIIIA}$$

$$\bar{x} = \frac{17\%}{16\%} \times 80$$

$$\bar{x} = 17 \times 5$$

$$\bar{x} = 85$$

b. Average of VIIID

$$\bar{x} = \frac{\%\,\text{VIIID}}{\%\,\text{VIIIA}} \times \text{average VIIIA}$$

$$\bar{x} = \frac{18\%}{16\%} \times 80$$

$$\bar{x} = 18 \times 5$$

$$\bar{x} = 90$$

c. Average of VIIIE

$$\bar{x} = \frac{\%\,\text{VIIIE}}{\%\,\text{VIIIA}} \times \text{average VIIIA}$$

$$\bar{x} = \frac{17\%}{16\%} \times 80$$

$$\bar{x} = 17 \times 5$$

$$\bar{x} = 85$$

Thus, the average of class VIIIC=85, VIIID=90, and VIIIE=85

Figure 2. Completion of MA subject tests

In Figure 2 it shows that subject V1 has written carefully and answered correctly. The following is a transcript of the interview with subject V1.

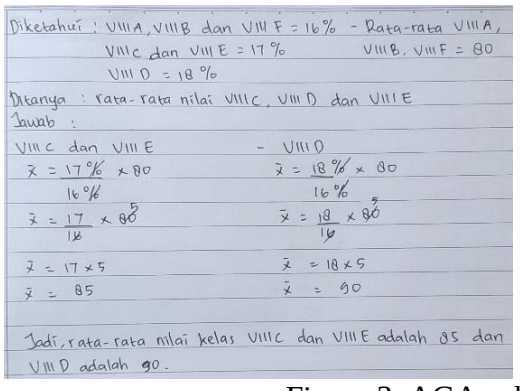
P: In question number 1, do you understand and comprehend the question from the question?
V1: Yes, I understand, ma'am.
P: What information is obtained from question number 1?

V1: The information I obtained in question number 1 is the average percentage of the class and the average of class VIII-A, VIII-B, and VIII-F.
P: Are you sure about the results of the solution you gave?
V1: I am sure, ma'am, because I have checked my solution again. But I don't know whether it is true or not.

Based on the dialogue, it can be concluded that student (V1) shows an understanding of the question in question number 1 by being able to identify relevant information, namely the average percentage of the class and the average of each class VIII-A, VIII-B, and VIII-F. Although the student feels confident about the solution given, there is doubt regarding the accuracy of the answer, even though a recheck has been carried out. This shows that although the student has a good initial level of understanding, confidence in the correctness of the results obtained still needs to be strengthened, which can be achieved through additional guidance or feedback from the teacher.

Subject 2: AGA

Subject A1 with the initials AGA answered question number 1 carefully and compiled a detailed solution. However, subject A1 did not include the information contained in question number 1 completely. At the analysis stage, subject A1 did not include the average formula. At the evaluation stage, subject A1 successfully calculated and wrote the correct solution. At the inference stage, subject A1 was able to draw conclusions correctly. Subject A1 had fulfilled the steps to solve question number 1 and demonstrated critical thinking skills. However, in the solution process, subject A1 was not careful, because there were still errors in the solution. On the other hand, subject A2 also succeeded in fulfilling the steps to solve the question, according to the critical thinking ability indicator. The results of A1's solution are in Figure 3.



Given: VIIIA, VIIIB and VIIIF=16% - The average VIIIA, VIIIB, VIIIF=80
VIIIC and VIIIE=17%
VIIID=18%
Find: the average value of VIIIC, VIIID and VIIIE
Answer

VIIIC and VIIIE	VIIID
$\bar{x} = \frac{17\%}{16\%} \times 80$	$\bar{x} = \frac{18\%}{16\%} \times 80$
$\bar{x} = 17 \times 5$	$\bar{x} = 18 \times 5$
$\bar{x} = 85$	$\bar{x} = 90$

Thus, the average value of class VIIIC and VIIIE are 85, and VIIID is 90.

Figure 3. AGA subject test completion

In Figure 3, it shows that subject A1 has written carefully and answered correctly. The following is a transcript of the interview with subject A1.

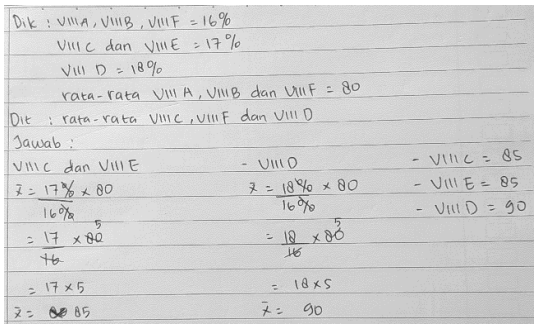
P: In question number 1, do you understand and comprehend the question from the question?
A1: Yes, I understand a little, ma'am.
P: What information do you get from question number 1?

A1: The information I got in question number 1 was that I was told to find the average of the other classes, ma'am.
P: Are you sure about the solution you gave?
A1: I'm not sure, ma'am, but I've checked my solution again.

Based on the dialogue, it can be concluded that student (A1) has a limited understanding of question number 1, because he only understands part of the question asked. The student is able to identify the main task of the question, which is to find the average of other classes, but does not show a deep understanding of the overall information presented. In addition, although the student has rechecked the solution given, the lack of confidence in the accuracy of the answer indicates doubt and lack of confidence in solving the problem. This indicates the need for strengthening conceptual understanding and further guidance to help students improve their critical thinking skills and confidence in solving problems.

Subject 2: ALA

Subject K1 with the initials ALA answered question number 1 carefully, but in writing the solution it was lacking in detail. Subject K1 did not present complete information from question number 1. At the analysis stage, subject K1 did not include the average formula. However, at the evaluation stage, subject K1 was able to do calculations and write the correct solution. At the inference stage, subject K1 was able to make conclusions, although incomplete. Subject K1 had fulfilled the steps to solve question number 1. Although subject K1 showed critical thinking skills, the solution process carried out was still not thorough because he made mistakes in solving. On the other hand, subject K2 succeeded in fulfilling the steps to solve the question, according to the indicators of critical thinking skills. The results of K1's solution can be seen in Figure 4.



Given: VIIIA, VIIIB, VIIIF=16%
VIIIC=17% and VIIIE=17%
VIIID=18%
The average of VIIIA, VIIIB, and VIIIF=80
Find: the average of VIIIC, VIIIF and VIIID
Answer

VIIIC and VIIID	VIIID	
$\bar{x} = \frac{17\%}{16\%} \times 80$	$\bar{x} = \frac{18\%}{16\%} \times 80$	- VIIIC=85 - VIIIE=85 - VIIID=90
$\bar{x} = 17 \times 5$	$\bar{x} = 18 \times 5$	
$\bar{x} = 85$	$\bar{x} = 90$	

Figure 4. ALA subject test completion

Based on Figure 4, it shows that subject K1 has written carefully and answered correctly. The following is a transcript of the interview with subject K1.

P: In question number 1, do you understand and comprehend the question of the question?
K1: I understand the question, ma'am.
P: What information do you get from question number 1?
K1: The information I got in question number 1 was that I was told to find the class average, ma'am.

P: Are you sure about the solution you gave?
K1: I'm not so sure, ma'am, but I've checked my solution again.

Based on the dialogue, it can be concluded that students (K1) understand the questions in question number 1 and are able to identify the main information, namely the task of finding the class average. However, even though students have re-checked the solution given, there is doubt about the correctness of the answer produced. This indicates that students' understanding of the steps for solving may not be fully mature, so that students' confidence in answering questions is also still low. This situation emphasizes the importance of providing additional explanations, more focused exercises, and feedback from teachers to help students strengthen their understanding of concepts and increase their confidence in solving questions.

DISCUSSION

The results of this study indicate that subjects V1 and A1 have good critical thinking skills, and are able to write critical thinking ability indicators that include analysis, evaluation, interpretation, and inference for each question given. Meanwhile, subject K1 showed less satisfactory results in answering the test, which was reflected in K1's inaccuracy in writing the solution, so that it did not achieve the expected critical thinking indicators. Table 2 presents a description of critical thinking skills based on learning styles

Table 2. Critical thinking across learning styles

Visual Subjects (V1 and V2)	Auditory Subjects (A1 and A2)	Kinesthetic Subjects (K1 and K2)
Question 1		
In question number 1, subjects V1 and V2 successfully met the main indicators of critical thinking skills, namely interpretation, analysis, evaluation, and inference. This can be seen because at the interpretation stage, students were able to write down what they understood or what was asked in the question. At the analysis stage, subjects V1 and V2 were able to write the formula so that at the evaluation stage they could write it correctly and precisely. At the inference stage, subjects V1 and V2 were able to write the conclusion correctly,	In question number 1, subjects A1 and A2 successfully met the main indicators of critical thinking skills, which include interpretation, analysis, evaluation, and inference. This can be seen because at the interpretation stage, students can write down the understanding or questions asked. At the analysis stage, subjects A1 and A2 did not write down the formula. At the evaluation stage, they can write it down correctly and precisely. At the inference step, subjects A1 and A2 can write down the conclusion correctly, namely the average value of the other classes.	In question number 1, subjects K1 and K2 successfully met the main indicators of critical thinking skills, namely analysis, evaluation, and inference. However, at the interpretation stage, students were unable to write down exactly what they understood or what was asked. At the analysis stage, subjects K1 and K2 did not write down the formula. At the evaluation step, they were able to write it down accurately and correctly. At the inference step, subjects K1 and K2 did not write down the conclusion correctly.

namely the average value of the other classes.		
Question 2		
In question number 2, subjects V1 and V2 successfully met the indicators of critical thinking skills, namely interpretation, analysis, evaluation, and inference. This can be seen because at the interpretation stage, students were able to write down what they understood or what was asked in the question. At the analysis stage, subjects V1 and V2 were able to write the formula so that at the evaluation stage they could write it correctly and precisely. At the inference stage, subjects V1 and V2 were able to write the conclusion correctly, namely the average rice and corn harvest in June.	In question number 2, subjects A1 and A2 successfully met the indicators of critical thinking skills, which include interpretation, analysis, evaluation, and inference. This can be seen because at the interpretation stage, students can write down the understanding or questions asked. At the analysis stage, subjects A1 and A2 did not write down the formula. At the evaluation stage, they can write it down correctly and precisely. At the inference step, subjects A1 and A2 can write down the conclusion correctly, namely the average rice and corn harvest in June.	In question number 2, subjects K1 and K2 successfully met the indicators of critical thinking skills, namely analysis, evaluation, and inference. However, at the interpretation stage, students were unable to write down exactly what they understood or what was asked. At the analysis stage, subjects K1 and K2 did not write down the formula. At the evaluation step, they were able to write it down accurately and correctly. At the inference step, subjects K1 and K2 did not write down the conclusion correctly.
Question 3		
In question number 3, subjects V1 and V2 successfully fulfilled the indicators of critical thinking skills, namely interpretation, analysis, evaluation, and inference. This can be seen because at the interpretation stage, students were able to write down what they understood or what was asked in the question. At the analysis stage, subjects V1 and V2 were able to write the formula so that at the evaluation stage they could write it correctly and precisely. At the inference stage, subjects V1 and V2 were able to write the conclusion correctly, namely the average value of students' height and the	In question number 3, subjects A1 and A2 successfully met the indicators of critical thinking skills, which include interpretation, analysis, evaluation, and inference. This can be seen because at the interpretation stage, students can write down the understanding or questions asked. At the analysis stage, subjects A1 and A2 did not write down the formula. At the evaluation stage, they can write it down correctly and precisely. At the inference step, subjects A1 and A2 can write down the conclusion correctly, namely the average value of students' height and the median.	In question number 3, subjects K1 and K2 successfully met the indicators of critical thinking skills, namely analysis, evaluation, and inference. However, at the interpretation stage, students were unable to write down exactly what they understood or what was asked. At the analysis stage, subjects K1 and K2 did not write down the formula. At the evaluation step, they were able to write it down accurately and correctly. At the inference step, subjects K1 and K2 did not write down the conclusion correctly.

median.

Question 4		
In question number 4, subjects V1 and V2 successfully fulfilled the indicators of critical thinking skills, namely interpretation, analysis, evaluation, and inference. This can be seen because at the interpretation stage, students were able to write down what they understood or what was asked in the question. At the analysis stage, subjects V1 and V2 were able to write the formula so that at the evaluation stage they could write it correctly and precisely. At the inference stage, subjects V1 and V2 were able to write the conclusion correctly, namely the average value and mode.	In question number 4, subjects A1 and A2 successfully met the indicators of critical thinking skills, which include interpretation, analysis, evaluation, and inference. This can be seen because at the interpretation stage, students can write down the understanding or questions asked. At the analysis stage, subjects A1 and A2 did not write down the formula. At the evaluation stage, they can write it down correctly and precisely. At the inference stage, subjects A1 and A2 can write down the conclusion correctly, namely the average value and mode.	In question number 4, subjects K1 and K2 successfully met the indicators of critical thinking skills, namely analysis, evaluation, and inference. However, at the interpretation stage, students were unable to write down exactly what they understood or what was asked. At the analysis stage, subjects K1 and K2 did not write down the formula. At the evaluation step, they were able to write it down accurately and correctly. At the inference step, subjects K1 and K2 did not write down the conclusion correctly.
Question 5		
In question number 5, subjects V1 and V2 successfully fulfilled the indicators of critical thinking skills, namely interpretation, analysis, evaluation, and inference. This can be seen because at the interpretation stage, students were able to write down what they understood or what was asked in the question. At the analysis stage, subjects V1 and V2 were able to write the formula so that at the evaluation stage they could write it correctly and precisely. At the inference stage, subjects V1 and V2 were able to write the conclusion correctly, namely the average, median, and mode.	In question number 5, subjects A1 and A2 successfully met the indicators of critical thinking skills, which include interpretation, analysis, evaluation, and inference. This can be seen because at the interpretation stage, students can write down the understanding or questions asked. At the analysis stage, subjects A1 and A2 did not write down the formula. At the evaluation stage, they can write it down correctly and precisely. At the inference stage, subjects A1 and A2 can write down the conclusion correctly, namely the average, median, and mode.	In question number 5, subjects K1 and K2 successfully met the indicators of critical thinking skills, namely analysis, evaluation, and inference. However, at the interpretation stage, students were unable to write down exactly what they understood or what was asked. At the analysis stage, subjects K1 and K2 did not write down the formula. At the evaluation stage, they were able to write it down accurately and correctly. At the inference stage, subjects K1 and K2 did not write down the conclusion correctly.

Based on Table 2, in line with the statement of Syahrir et al. (2023) shows that students with a visual learning style have better connection skills than students with a kinesthetic and auditory learning style. Setiana and Purwoko (2020) identified critical thinking skills based on learning styles and concluded that students with a visual learning style are in the very good category, students with a kinesthetic learning style are in the good category, and students with an auditory learning style are in the sufficient category.

Based on the research results, mathematics teachers need to adapt learning strategies to accommodate students' different learning styles in order to improve their critical thinking skills. Visual students can be helped with diagrams and mind maps, auditory students with discussions and sound recordings, and kinesthetic students with project-based activities and teaching aids. Teachers also need to improve mathematical connections through contextual problems, PBL approaches or inquiry-based learning, as well as differentiated assessments that are tailored to students' learning styles. Collaboration between students can be strengthened through heterogeneous study groups and discussions. With the right strategies, students' critical thinking skills and mathematical connections can be improved effectively.

CONCLUSION

Based on the research results, the following conclusions are drawn: 1) students with visual learning styles have very good critical thinking skills, being able to meet indicators such as interpretation, analysis, evaluation, and inference; 2) students with auditory learning styles show good critical thinking skills, being able to meet indicators of analysis, evaluation, and inference, although still lacking in the interpretation aspect; and 3) students with kinesthetic learning styles show fairly good critical thinking skills, but have not met the analysis and evaluation indicators. Overall, students with visual learning styles are categorized as very good at critical thinking, because they are better able to describe mathematical concepts visually before solving problems. However, students with auditory and kinesthetic learning styles also have the potential to develop critical thinking skills.

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REFERENCES

Arafah, R. A. D., Isnainiwati, Hartatik, & Mulyawan, B. T. (2025). Students ' Critical Thinking Ability in Solving PISA Problems Based on Field Dependent and Field Independent Cognitive Styles. *International Journal of Human Research and Social Science Studies, 02*(01), 11–18. https://doi.org/https://doi.org/10.55677/ijhrsss/02-2025-Vol02I1

Aristin, N. F., & Purnomo, A. (2022). Improving Critical Thinking Skill Through Team-based Projects, is it Effective? *Journal of Education Research and*

Evaluation, *6*(4), 586–594. https://doi.org/10.23887/jere.v6i4.48090

Atieku, J. N., Segbefia, S. K., & Gyampoh, A. O. (2023). Effect of Audio-visual Aids on Students Understanding: A Comparative Analysis of JHS students in the Ho Municipality. *Integrated Journal for Research in Arts and Humanities*, *3*(5), 46–57. https://doi.org/10.55544/ijrah.3.5.4

Bahri, M., Susilo, B. E., & Sutarto, H. (2024). Students' Critical Thinking Abilities Based on Cognitive Style in STEM-Integrated Problem-Based Learning. *Journal of Hunan University Natural Sciences*, *51*(1), 73–81. https://doi.org/10.55463/issn.1674-2974.51.1.8

Behzadi, S., & Momennasab, M. (2023). The relationship between learning style, thinking and critical thinking tendency with lifestyle improvement in controlling cardiovascular diseases in medical students of Islamic Azad University, Arsanjan Branch. *Revista Latinoamericana de Hipertensión*, *18*(1), 1–9.

Budiyanto, Kabri, K., Harapan, E., & Purwanto, M. B. (2024). 21st Century English Learning: a Revolution in Skills, Critical Thinking, Creativity, and Visual Communication. *Asian Journal of Applied Education (AJAE)*, *3*(1), 43–54. https://doi.org/10.55927/ajae.v3i1.7841

Casinillo, L. F. (2023). Quantile Regression Analysis for Students' Difficulty Level in Learning Statistics Online. *JPI (Jurnal Pendidikan Indonesia)*, *12*(4), 607–614. https://doi.org/10.23887/jpiundiksha.v12i4.66752

Dolapcioglu, S., & Doğanay, A. (2022). Development of Critical Thinking in Mathematics Classes Via Authentic Learning: an Action Research. *International Journal of Mathematical Education in Science and Technology*, *53*(6), 1363–1386. https://doi.org/10.1080/0020739X.2020.1819573

Dominguez, L. G. I., Robles-Gomez, A., & Pastor-Vargas, R. (2025). A data-driven approach to engineering instruction: exploring learning styles, study habits, and machine learning. *IEEE Access*, *13*(January), 10978–11002. https://doi.org/10.1109/ACCESS.2025.3528263

Facione, P. a. (2011). Critical Thinking : What It Is and Why It Counts. In *Insight assessment* (Issue ISBN 13: 978-1-891557-07-1.).

Fauziyyah, F., & Nurjanah. (2024). Eksplorasi Penggunaan Game Edukasi dalam Pembelajaran Statistika untuk Mengembangkan Kemampuan Berpikir Kritis Siswa SMP. *Jurnal Pendidikan Matematika*, *8*(2), 358–368. https://doi.org/10.33087/phi.v8i2.407

Guo, R., Jantharajit, N., & Thongpanit, P. (2024). Enhancing Analytical and Critical Thinking Skills through Refl ective and Collaborative Learning: A Quasi-Experimental Study. *Journal of Education and Education Development*, *11*(2), 200–223.

Irwan, Arnandi, & Aslan. (2024). Developing Critical Thinking Skills Of Primary School Students Through Independent Curriculum Learning. *Indonesian Journal of Education (INJOE)*, *4*(3), 788–803. https://doi.org/10.25688/2076-9121.2024.18.1-1.03

Musyafak, A., & Agoestanto, A. (2022). Pengembangan Bahan Ajar Statistika Bermuatan Soal Literasi Numerasi Bernuansa STEM untuk Meningkatkan Kemampuan Berpikir Kritis Peserta Didik pada PBL. *Jurnal Tadris Matematika*, *5*(2), 273–284. https://doi.org/10.21274/jtm.2022.5.2.273-284

Purwanto, W. R., Waluya, S. B., Rochmad, & Wardono. (2020). Analysis of

mathematical critical thinking ability in student learning style. *Journal of Physics: Conference Series*, *1511*(1). https://doi.org/10.1088/1742-6596/1511/1/012057

Setiana, D. S., & Purwoko, R. Y. (2020). Analisis Kemampuan Berpikir Kritis Ditinjau dari Gaya Belajar Matematika Siswa. *Jurnal Riset Pendidikan Matematika*, *7*(2), 163–177. https://doi.org/10.21831/jrpm.v7i2.34290

Sugiyono. (2019). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Bandung: Alfabeta.

Suryani, T., & Haryadi, R. (2022). Analisis Kemampuan Berpikir Kritis pada Materi Statistika Siswa Kelas VII MTs Assalam Pontianak. *Jurnal Prodi Pendidikan Matematika (JPMM)*, *4*(1), 345–364. https://doi.org/10.30598/jmsvol1issue1pp16-22

Syahrir, Nur, F. A. M., As, M., & Pujirianto. (2023). The Correlation Between Visual, Auditory, and Kinesthetic (VAK) Learning Styles on Learning Independence of 8Th Grade Students in State Junior High Schools in Yogyakarta City, Indonesia. *European Journal of Education Studies*, *10*(12), 244–259. https://doi.org/10.46827/ejes.v10i12.5115

Szabo, Z. K., Körtesi, P., Guncaga, J., Szabo, D., & Neag, R. (2020). Examples of Problem-Solving Strategies in Mathematics Education Supporting the Sustainability of 21st-Century Skills. *Sustainability (Switzerland)*, *12*(23), 1–28. https://doi.org/10.3390/su122310113

Tarso, Siswanto, D. H., & Setiawan, A. (2025). Teacher qualifications in the implementation of the Kurikulum Merdeka and ISMUBA. *Curricula: Journal of Curriculum Development*, *4*(1), 13–28.

Ying, W. (2024). Influence of Students' Learning Style Preferences on Students Success: Moderating Impact of Information and Communication Technologies Effectiveness. *Profesional de La Informacion*, *33*(4), 1–10. https://doi.org/10.3145/epi.2024.ene.0414